

CLAIMS

1. A composite semiconductor structure comprising:
a substrate of a monocrystalline noncompound
5 semiconductor material;
at least one accommodating layer, each said
accommodating layer comprising at least in part an
amorphous oxide material and overlying a respective area
of said monocrystalline noncompound semiconductor
10 substrate;
at least one portion of a monocrystalline
compound semiconductor material, each said portion
overlying a respective one of said at least one
accommodating layer;
15 an optical testing structure in at least one of
said monocrystalline noncompound and compound
semiconductor materials for testing elements of said
composite semiconductor structure.

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2. A composite semiconductor structure comprising:
a substrate of a monocrystalline noncompound semiconductor material;

5 at least one accommodating layer, each said accommodating layer comprising at least in part an amorphous oxide material and overlying a respective area of said monocrystalline noncompound semiconductor substrate;

10 at least one portion of a monocrystalline compound semiconductor material, each said portion overlying a respective one of said at least one accommodating layer;

15 a testing circuit in said monocrystalline noncompound semiconductor material, said testing circuit having at least one terminus in one of said portions of said monocrystalline compound semiconductor material; and

20 an optical element in said one portion, said optical element connected to said terminus of said testing circuit, said optical element being one of (a) an optical emitter and (b) an optical detector, for optical communication between said testing circuit and an external testing apparatus.

25 3. The composite semiconductor of claim 2 wherein said testing circuit is a scan chain.

30 4. The composite semiconductor of claim 2 wherein said testing circuit has a terminus in one of said at least one portion, coupled to one of an optical emitter and optical detector.

5. The composite semiconductor of claim 2 wherein:

said at least one accommodating layer comprises a plurality of accommodating layers;

said at least a portion of said monocrystalline compound semiconductor material comprises a plurality of
5 portions of said monocrystalline compound semiconductor material;

said testing circuit has two said termini, each said terminus being in a different one of said plurality of areas of said monocrystalline compound semiconductor
10 material;

a first of said termini is connected to an optical emitter; and

a second of said termini is connected to an optical detector.

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6. The composite semiconductor of claim 5 wherein said testing circuit is a scan chain.

7. The composite semiconductor of claim 6
20 comprising:

a plurality of said scan chains;

a corresponding plurality of said optical emitters; and

a corresponding plurality of said optical
25 detectors; wherein:

each said scan chain has one said first terminus connected to one of said corresponding plurality of said optical emitters and one said second terminus connected to one of said corresponding plurality of
30 optical detectors.

8. The composite semiconductor structure of claim 7 wherein each said optical emitter comprises a light emitting diode.

5 9. The composite semiconductor structure of claim 7 wherein each said optical emitter comprises a laser.

10 10. The composite semiconductor structure of claim 9 wherein said laser is a vertical cavity surface emitting laser.

11. The composite semiconductor structure of claim 5 wherein said optical emitter comprises a light emitting diode.

15 12. The composite semiconductor structure of claim 5 wherein said optical emitter comprises a laser.

20 13. The composite semiconductor structure of claim 12 wherein said laser is a vertical cavity surface emitting laser.

14. A method for testing a composite semiconductor structure, said method comprising:

providing a composite semiconductor structure,
5 said structure comprising:

a substrate of a monocrystalline noncompound semiconductor material,

at least one accommodating layer, each said at least one accommodating layer comprising at least in part
10 an amorphous oxide material and overlying a respective portion of said monocrystalline noncompound semiconductor substrate,

at least one portion of a monocrystalline compound semiconductor material, each said portion
15 overlying a respective one of said at least one accommodating layer,

a testing circuit in said monocrystalline noncompound semiconductor material, said testing circuit having at least one terminus in one of said portions of
20 said monocrystalline compound semiconductor material, and

a structure optical element in said one portion, said structure optical element connected to said terminus of said testing circuit, said optical element being one of (a) a structure optical emitter and (b) a
25 structure optical detector;

providing a testing apparatus having an optical interface, said optical interface comprising one of (a) a tester optical detector, and (b) a tester optical emitter;

30 aligning said optical interface for optical communication with said structure optical element; and

propagating test signals through said testing circuit via optical communication between said optical

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interface and said structure optical element.

15. The method of claim 14 wherein said providing a composite semiconductor structure comprises providing
5 said composite semiconductor wherein:

said at least one accommodating layer comprises a plurality of accommodating layers;

said at least a portion of said monocrystalline compound semiconductor material comprises a plurality of
10 portions of said monocrystalline compound semiconductor material;

said testing circuit has two said termini, each said terminus being in a different one of said plurality of portions of said monocrystalline compound
15 semiconductor material;

a first of said termini is connected to an optical emitter; and

a second of said termini is connected to an optical detector.

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16. The method of claim 15 wherein said providing a composite semiconductor structure comprises providing said composite semiconductor structure wherein said testing circuit is a scan chain.

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17. The method of claim 16 wherein said providing a composite semiconductor structure comprises providing said composite semiconductor comprising:

a plurality of said scan chains,
30 a corresponding plurality of said optical emitters, and

a corresponding plurality of said optical detectors; wherein:

each said scan chain has one said first terminus connected to one of said corresponding plurality of said optical emitters and one said second terminus connected to one of said corresponding plurality of optical detectors.

18. The method of claim 17 wherein said providing a composite semiconductor structure comprises providing said composite semiconductor structure wherein each said optical emitter comprises a light emitting diode.

19. The method of claim 17 wherein said providing a composite semiconductor structure comprises providing said composite semiconductor structure wherein each said optical emitter comprises a laser.

20. The method of claim 19 wherein said providing a composite semiconductor structure comprises providing said composite semiconductor structure wherein said laser is a vertical cavity surface emitting laser.

21. The method of claim 15 wherein said providing a composite semiconductor structure comprises providing said composite semiconductor structure wherein said optical emitter comprises a light emitting diode.

22. The method of claim 15 wherein said providing a composite semiconductor structure comprises providing said composite semiconductor structure wherein said optical emitter comprises a laser.

23. The method of claim 22 wherein said providing a composite semiconductor structure comprises providing

said composite semiconductor structure wherein said laser is a vertical cavity surface emitting laser.

24. The method of claim 14 wherein said providing a testing apparatus comprises providing said testing apparatus wherein:

said optical interface comprises:

a substrate of a second monocrystalline noncompound semiconductor material,

at least another accommodating layer, each said at least another accommodating layer comprising at least in part an amorphous oxide material and overlying a respective portion of said second monocrystalline noncompound semiconductor substrate, and

at least one portion of a second monocrystalline compound semiconductor material, each said portion overlying a respective one of said at least another accommodating layer; and

said one of (a) said tester optical detector, and (b) said tester optical emitter, is in said at least one portion of said second monocrystalline compound semiconductor material.

25. The method of claim 24 wherein said providing a testing apparatus comprises providing said testing apparatus wherein said optical interface comprises at least one of each of (a) said tester optical detector, and (b) said tester optical emitter.

26. The method of claim 14 wherein said providing a testing apparatus comprises providing said testing apparatus wherein said optical interface comprises at

least one of each of (a) said tester optical detector,
and (b) said tester optical emitter.

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27. A composite semiconductor structure comprising:
a substrate of a monocrystalline noncompound semiconductor material;

5 at least one accommodating layer, each said at least one accommodating layer comprising at least in part an amorphous oxide material and overlying a respective area of said monocrystalline noncompound semiconductor substrate;

10 at least one portion of a monocrystalline compound semiconductor material, each said portion overlying a respective one of said at least one accommodating layer;

an optical detector element in said
15 monocrystalline noncompound semiconductor material;
an optical emitter element in said one portion;
and

an optical waveguide extending in said one portion in optical communication with said optical
20 emitter element and overlying said optical detector element; wherein:

said composite semiconductor structure when correctly fabricated has a further circuit element between said optical waveguide and said optical detector
25 element; whereby:

said optical emitter element, said optical waveguide and said optical detector element form an optical test element for testing for presence or absence of said further circuit element.

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28. The composite semiconductor structure of claim 27 wherein said optical waveguide has a leaky side facing said optical detector element.

29. The composite semiconductor structure of claim
27 wherein said further circuit element, the presence or
absence of which is to be tested, comprises
5 metallization.

30. The composite semiconductor structure of claim
27 comprising a plurality of said optical test elements.

10 31. The composite semiconductor structure of claim
30 wherein said optical emitter of each said optical test
element comprises a light emitting diode.

15 32. The composite semiconductor structure of claim
30 wherein said optical emitter of each said optical test
element comprises a laser.

20 33. The composite semiconductor structure of claim
32 wherein said laser is a vertical cavity surface
emitting laser.

25 34. The composite semiconductor structure of claim
30 wherein said optical detector comprises a
photodetecting diode.

35 35. The composite semiconductor structure of claim
34 wherein said photodetecting diode comprises a PIN
diode.

30 36. The composite semiconductor structure of claim
27 wherein said optical emitter comprises a light
emitting diode.

37. The composite semiconductor structure of claim 27 wherein said optical emitter comprises a laser.

38. The composite semiconductor structure of claim
5 37 wherein said laser is a vertical cavity surface
emitting laser.

39. The composite semiconductor structure of claim
27 wherein said optical detector comprises a
10 photodetecting diode.

40. The composite semiconductor structure of claim 39 wherein said photodetecting diode comprises a PIN diode.

41. A method for testing a composite semiconductor structure, said method comprising:

providing a composite semiconductor structure,
5 said structure comprising:

a substrate of a monocrystalline noncompound semiconductor material,

at least one accommodating layer, each said accommodating layer comprising at least in part an
10 amorphous oxide material and overlying a respective area of said monocrystalline noncompound semiconductor substrate,

at least one portion of a monocrystalline compound semiconductor material, each said portion
15 overlying a respective one of said at least one accommodating layer,

an optical detector element in said first monocrystalline semiconductor material,

an optical emitter element in said one portion,
20 and

an optical waveguide extending in said one portion in optical communication with said optical emitter element and overlying said optical detector element;

25 energizing said optical emitter element to generate a signal;

monitoring said optical detector element; and

signifying an improperly fabricated composite semiconductor structure when said signal is detected,

30 wherein said composite semiconductor structure when correctly fabricated has a further circuit element between said optical waveguide and said optical detector element that at least partially blocks said signal.

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42. The method of claim 41 wherein said providing a composite semiconductor structure comprises providing said structure with said optical waveguide having a leaky
5 side facing said optical detector element.

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